DATE, RATE, & PLACE

The Field Book for Dairy Manure Applicators

A PACIFIC NORTHWEST EXTENSION PUBLICATION • PNW506

Prepared by Andy Bary, Washington State University, and Joe Harrison, Washington State University. Previous authors include Dan Sullivan, Oregon State University, and Craig Cogger, Washington State University.

CONTENTS

HOW TO USE THIS BOOK

Field record-keeping is a key part of manure management. It includes

- Where manure was applied
- How much manure was applied
- When manure was applied

Good records help you make the most of your farm's manure. They give you the information you need to plan, carry out, and refine management.

Manure record-keeping is often a neglected task, but can be done easily. In the long run, it can save you time, energy, and money.

This book provides a simple format for recording manure applications. You can record applications using convenient units such as the number of spreader loads or inches of slurry.

This book is for field use. We suggest you keep it in your vehicle or wherever it's handy for making a few notes each application day.

To use your records for nutrient management purposes, you will need to convert field units (e.g., spreader loads per acre) into nutrient application rates (lb nutrients per acre). Call upon local experts (Extension agents, consultants, conservation district, or NRCS staff) for assistance.

WHAT'S INSIDE

The first section of the book is for record-keeping. It includes

- Blank manure application record sheets. Use these to record manure application data on a field-by-field basis. These sheets include space to note the field ID, crop acres, type of manure, date, location, weather, and amount of manure applied.
- Examples of manure records for different manure handling systems.

We provide manure management tips as food for thought.

The second section of the book contains supplemental information for manure management, including:

- Ways to calibrate manure application equipment
- Typical manure nutrient concentrations for different handling systems
- Tables for recording manure nitrogen quick test results
- Conversion factors for manure application rates
- Instructions for sampling manure for nutrient analysis
- Suggested sources for more information

MANURE APPLICATION TIPS

- Apply manure to grass at least 21 days before first cutting so disease-causing bacteria and viruses will die off. Applying manure within 7 days after cutting reduces the chance of smothering grass and slowing regrowth.
- Calibrate manure spreaders, tank wagons, and other application equipment annually so you know how much manure you are applying.
- Before planning mid-season nitrogen applications to corn, sample soils to determine if additional nitrogen is needed. This is called a pre-sidedress nitrogen test (PSNT). See OSU publication PNW 615.
- Plant relay crops or winter cover crops in rotation with corn to reduce nutrient loss.
- Use laboratory tests annually and use quick tests more frequently to track the nutrient and solids content of all types of manure on your farm, including slurry, separated solids, and bedding.
- In western Washington, use the Application Risk Management (ARM) program to help decide when to spread manure (http://www.whatcomcd.org/arm). For other areas in the Pacific Northwest, check with you state's Department of Agriculture.
- Sample your soils for post-harvest nitrate between August 15 and October 15 prior to 3 inches of rain on sandy soils or 5 inches of rain on other soil types, or as directed by applicable permits. This fall soil test will show if you are applying sufficient or excess manure nitrogen to your fields.
- Consider off-farm marketing of nutrient-rich separated dairy solids.
- Soil testing is the best way to determine manure application effects on plant-available phosphorus (P) and potassium (K). Sample soils for total P and total K every 2 or 3 years, or as directed by applicable permits. See OSU publication EC 628.

Example 1. Lagoon liquid manure applied to grass silage

Field ID 1 Acres 24 Crop Grass silage Seeding Date Fall 2015

Date	Weather	Manure Type	Amount	Comments, application method
3/12/16	Sunny	Liquid	1/2 inch*	No agitation, pumped off top
4/16/16	Broken clouds	Liquid	1/2 inch	Lagoon agitated
7/4/16	Sunny	Liquid	2 inches	Agitated mixed with water
8/10/16	Partial cloud cover	Liquid	1/2 inch	Agitated and emptied lagoon

*Measured with buckets in field

Example 2. Separated solids and lagoon liquid applied to corn with triticale cover crop

Field ID 2 Acres 40 Crop Triticale & corn Seeding Date triticale 10/15 corn 6/1

Date	Weather	Manure Type	Amount	Comments, application method
10/2/16	Cloudy	Separated solids	12 loads*	Start on N side
10/3/16	"	"	10 loads	Continue across field
10/9/16	Sunny	"	15 loads	Finish field

*1 load = 10 yards

Example 2. (continued)

Field ID 2 Acres 40 Crop Triticale & corn Seeding Date triticale 10/15 corn 6/1

Date	Weather	Manure Type	Amount	Comments, application method
3/15/17	Overcast	Liquid	4 hr big gun**	Covered N 1/4 of field
3/16/17	Sunny	Liquid	4 hr big gun	Field half done

**big gun = 375 gpm, ground speed = 5ft/min

Example 3. Holding tank slurry applied by honey wagon to grass pasture

Field ID Old Oak Tree Acres 20 Crop Orchard grass Seeding Date Fall 2015

Date	Weather	Manure Type	Amount	Comments, application method
3/1/17	Overcast	Slurry	6 loads*	1 acre, 1/2 inch applied
3/2/17	Partial cloud cover	"	12 loads	2 acres
3/3/17	Partial sun	"	10 loads	2 acres

*1 load = 2,000 gallons

Example 4. Dry stack manure applied to corn

Field ID 4 Acres 100 Crop Corn Seeding Date 5/10/17

Date	Weather	Manure Type	Amount	Comments, application method
4/6/17	Sunny	Dry stack	20 loads*	Lots of straw, 2/loads/acre
4/7/17	Light wind	"	30 loads	Less straw
4/8/17	Calm	"	18 loads	Mostly manure/little straw
4/12/17	Sunny	"	8 loads	Little straw, finish field

*1 load = 15 yards

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

MANURE APPLICATION RECORD

Field ID_____ Acres_____ Crop_____ Seeding Date_____

Date	Weather	Manure Type	Amount	Comments, application method

Date	Weather	Manure Type	Amount	Comments, application method

CALIBRATING MANURE APPLICATIONS

The following pages outline how to calibrate your manure spreader, wagon, or big gun to estimate how much manure you applied in tons per acre or gallons per acre. Because variability of manure applications is typically high, these calibrations are only estimates.

You can calibrate manure applications by measuring a small part of the manure applied, using tarps, pans, or buckets, covering a known area. Or you can weigh an entire spreader load and measure how much area the load covers. Regardless of which calibration you use, recheck your measurements periodically to make sure you stay on target.

Worksheet A. Spreader calibration (by weight) using bucket pan or tarp

1. Place bucket, pans, or tarps in the application area to collect manure.
2. Spread manure over application area using the spreading pattern typically used in the field. Make sure the spreader is traveling at the speed it typically travels over the collection area. Record tractor rpm and gear settings used.
3. Collect and weigh manure, and calculate an average application rate. Use this worksheet to record your weights and calculations.

Note: If you are spreading dry stack manure or separated solids, use tarps instead of buckets. Because tarps cover a larger area, variability is less.

Date _____

Field _____

Spreader ID _____

RPM _____

Gear _____

Operator _____

Worksheet A (continued)

	Example	A	B	C	D	E	F
1. Weight of empty bucket (lb)	1.3						
2. Weight of manure and bucket (lb)	2.2						
3. Weight of manure (lb) (line 2 – line 1)	.9						
4. Bucket/tarp (sq ft)	.6						
5. Manure applied (lb/sq ft) (line 3 ÷ line 4)	1.5						
6. Convert to tons/acre (line 5 × 21.78)	32.7						
7. Average application rate (average over all locations)							

Worksheet B. Spreader calibration (by weight) using a full spreader load

Use this method to monitor the manure application rate on the entire field. After initial weighing, which determines the capacity of the application vehicle, the only tool needed is a measuring wheel or long tape measure.

1. Determine the weight of manure the spreader will hold. Use truck scales to weigh the spreader when empty and full.
2. Fill the spreader and spread a load on the field, using tractor speed and settings to cover the field uniformly. Spread in a rectangular pattern, so the area calculation will be simple. Record the tractor rpm and gear settings used.
3. Measure the length and width covered by one full load and compute the application rate in tons per acre using the worksheet.

Date _____

Field _____

Spreader ID _____

RPM _____

Gear _____

Operator _____

Worksheet B (continued)	Example	A	B	C
1. Weight of empty spreader (lb)	2,000			
2. Weight of loaded spreader (lb)	12,000			
3. Weight of manure in spreader (lb) (line 2 – line 1)	10,000			
4. Length of spread (ft)	1,400			
5. Width of spread (ft)	15			
6. Area of spread (sq ft) (line 4 × line 5)	21,000			
7. Manure applied (lb/sq ft) (line 3 ÷ line 6)	.476			
8. Convert to ton/acre (line 7 x 21.78)	10.4			

Worksheet C. Manure wagon calibration (by volume) using a full tank load

This method is similar to the spreader load method, except that it uses volume rather than weight.

1. Look in the owner's manual for your manure wagon to determine maximum rated capacity.
2. Multiply the maximum rated capacity by 0.8. This is the approximate filled volume of the tank.
3. Fill the tank and spread a load on the field using tractor speed and settings to cover the field uniformly. Spread a rectangular pattern so the area calculation will be simple. Record tractor rpm and gear settings used.
4. Measure the length and width covered by one full load and compute the application rate in gallons per acre using this worksheet.

Date _____

Field _____

Spreader ID _____

RPM _____

Gear _____

Operator _____

Worksheet C (continued)

	Example	A	B	C
1. Maximum rated capacity of tank (gal)	2,500			
2. Volume of filled load (gal) (line 1 × 0.8)	2,000			
3. Length of area spread (ft)	700			
4. Width of area spread (ft)	14			
5. Area spread (sq ft) (line 3 × line 4)	9,800			
6. Manure applied (gal/sq ft) (line 2 ÷ line 5)	0.204			
7. Convert to gal/acre (line 6 × 43,560)	8,890			

Worksheet D. Big gun calibration (by volume) using buckets

This measurement can help you verify that your big gun output is close to the amount you expect. It can also help you observe application variability across the width of the gun pattern.

1. Use 5 to 10 straight-walled, flat-bottomed buckets to collect the liquid manure. All buckets must have the same diameter.
2. Place one of the buckets on a level surface and fill it with water to a known depth (1–3 inches). Pour water from the bucket into a large measuring cup. Determine how many measuring cups of water are in the bucket.
3. Place at least 5 buckets across the track of the big gun at one or more locations along the length of the track. Put a rock or other weight in each bucket to keep them upright. After the gun has passed, measure the liquid in each bucket using a calibrated measuring cup from step 2. Convert the volume to inches. (See conversion table for conversion from inches to gallons.)

Date _____

Bucket calibration:

Example

1 inch = 5 cups

1 cup = .20 inches

Your bucket

1 inch = ____ cups

1 cup = ____ inches

Worksheet D (continued) **Example**

Bucket ID	Cups	Inches	Cups	Inches	Cups	Inches
1	4	0.8				
2	5	1.0				
3	6	1.2				
4	3	0.6				
5	4	0.8				
6	6	1.2				
7	5	1.0				
8	3	0.6				
9	6	1.2				
10	2	0.4				
Average		0.9				

TYPICAL MANURE NUTRIENT CONCENTRATIONS FOR DIFFERENT HANDLING SYSTEMS

The tables below show typical values of nutrient content of dairy manure handled different ways. You can use them as a rough estimate of nutrient content of your manure. Because manure nutrient content varies widely among farms and even over time on the same farm, we recommend manure testing to get figures that are realistic for your farm.

NITROGEN

Manure Type	Units	Typical Total Nitrogen	First Year Fertilizer Value (% of Total N)
Dry stack (35% solids)	lb/wet ton	7–11	10–20
Separated solids (20% solids)	lb/wet ton	3–7	0–20
Holding tank (scraped, 8% solids)	lb/1,000 gal	18–24	30–60
Lagoon, no agitation (<1% solids)	lb/1,000 gal	2–6	60–90
Lagoon, agitated (2–6% solids)	lb/1,000 gal	6–18	30–60

Note: Most of the manure nitrogen (N) that is not plant available in the first year is stored in soil organic matter. It is slowly converted to plant available forms in later years. Over a 5 year period, 60–90% of the manure N applied becomes plant available.

PHOSPHORUS AND POTASSIUM

Manure Type	Units	Total Phosphorus	Typical Potassium
Dry stack (35% solids)	lb/wet ton	3–5	10–20
Separated solids (20% solids)	lb/wet ton	0.7–1.3	1–3
Holding tank (scraped, 8% solids)	lb/1,000 gal	5–7	15–25
Lagoon, no agitation (<1% solids)	lb/1,000 gal	<0.5	2–8
Lagoon, agitated (2–6% solids)	lb/1,000 gal	1–5	10–20

Note: To convert phosphorus (P) to the same units used in marketing fertilizers (P_2O_5), multiply P × 2.29. Not all of the P in manure is immediately plant available.

To convert potassium (K) to fertilizer units (K_2O), multiply K × 1.20. Most of the manure K in manure is immediately plant available.

Soil tests are the best indicators of the long-term effects of manure application on soil fertility. Plan to test for P and K every 2 to 3 years.

MANURE QUICK TEST RECORDS

Use these pages to record results of manure quick tests done using a hydrometer or Agros/Nova meter. Quick tests are used as an estimate and need to be validated to laboratory results periodically.

Example

Date	**Manure** (liquid, slurry, etc.)	**Test** (hydrometer or Agros/Nova meter)	**Reading**	**Estimated Nitrogen** (lb/1,000 gal)*
4/11/16	Slurry	Hydrometer	4% solids	12 lb (total N)
7/1/16	Liquid	Agros/Nova	4 lb	4 lb (ammonium N)

*See the manufacturer's instructions for converting hydrometer or Agros/Nova meter readings to lb N/1,000 gallons manure.

Manure Quick Test Record

Date	**Manure** (liquid, slurry, etc.)	**Test** (hydrometer or Agros/Nova meter)	**Reading**	**Estimated Nitrogen** (lb/1,000 gal)*

*See the manufacturer's instructions for converting hydrometer or Agros/Nova meter readings to lb N/1,000 gallons manure.

Manure Quick Test Record

Date	**Manure** (liquid, slurry, etc.)	**Test** (hydrometer or Agros/Nova meter)	**Reading**	**Estimated Nitrogen** (lb/1,000 gal)*

*See the manufacturer's instructions for converting hydrometer or Agros/Nova meter readings to lb N/1,000 gallons manure.

Manure Quick Test Record

Date	**Manure** (liquid, slurry, etc.)	**Test** (hydrometer or Agros/Nova meter)	**Reading**	**Estimated Nitrogen** (lb/1,000 gal)*

*See the manufacturer's instructions for converting hydrometer or Agros/Nova meter readings to lb N/1,000 gallons manure.

MANURE SOLD OR GIVEN AWAY

Recipient		Address	City, State, Zip
Date	Weight or Volume	Notes	
Recipient		Address	City, State, Zip
Date	Weight or Volume	Notes	
Recipient		Address	City, State, Zip
Date	Weight or Volume	Notes	

MANURE SOLD OR GIVEN AWAY

Recipient		Address	City, State, Zip
Date	Weight or Volume	Notes	
Recipient		Address	City, State, Zip
Date	Weight or Volume	Notes	
Recipient		Address	City, State, Zip
Date	Weight or Volume	Notes	

CONVERSION FACTORS FOR MANURE APPLICATION RATES

AREA AND VOLUME

1 acre	=	43,560 square feet
1 acre-inch	=	27,000 gallons
1 acre-inch	=	134 cubic yards
1 cubic yard	=	27 cubic feet
1 cubic foot	=	7.5 gallons

APPROXIMATE MANURE WEIGHT AND VOLUME

1 cubic foot	=	60–65 lb			(fresh manure or slurry)
1 cubic yard	=	202 gal or 1,700 lb	=	0.85 tons	(fresh manure or slurry)
1 cubic yard	=	1,100 lb	=	0.55 tons	(separated solids)
1 cubic yard	=	1,400 lb	=	0.70 tons	(dry stack)
1,000 gal	=	4 tons			(fresh manure or slurry)
1 ton	=	1.2 cubic yards			(fresh manure or slurry)
1 ton	=	1.8 cubic yards			(separated solids)
1 ton	=	1.4 cubic yards			(dry stack)

SAMPLING MANURE FOR NUTRIENT ANALYSIS

Make sure the sample you collect is typical of manure at your farm. Usually, several individual samples are collected and mixed together to make a composite sample, which is analyzed for nutrient content.

How you sample depends on your storage and handling system:

- The greater the variability in manure composition, the more individual samples are needed to obtain a composite sample for nutrient analysis.
- For liquid manure, sample agitated manure immediately before application or collect samples of sprinkler-applied liquid in buckets placed in the field.
- For solid manure, take 10–20+ individual samples, and mix them to make one composite sample. If piles have substantially different amounts of bedding, you will get better information by taking separate composite samples from each pile.
- Liquid manure samples can be analyzed by on-farm quick tests or can be shipped to a laboratory for analysis.

SAMPLING MANURE FOR NUTRIENT ANALYSIS, continued

The Minnesota Department of Agriculture's website has a list of approved of laboratories for NRCS Environmental Quality Incentives Program (EQIP) and other programs (see Resources).

- Refrigerate or freeze samples to be sent to the laboratory.
- Plan shipment so the samples are not left unrefrigerated over the weekend. Samples should arrive at the laboratory within 48 hours of shipment.
- Check with your analytical laboratory to discuss appropriate containers, preservative methods, and sample delivery schedule.
- One-quart, wide-mouth plastic containers with tight-fitting lids are ideal for shipping liquid samples. Don't fill bottles more than three fourths full.

RESOURCES

AgWeatherNet.
http://www.weather.wsu.edu/?p=88650

Bary, A.C. Cogger, and D.M. Sullivan. Fertilizing with Manure. PNW 533. 2016.
http://cru.cahe.wsu.edu/CEPublications/PNW533/PNW533.pdf

Brown, B.D., J. Hart, and A. Moore. Nutrient Management for Field Corn Silage and Grain in the Pacific Northwest. PNW 615. 2010. https://pubs.wsu.edu/ListItems.aspx?Keyword=PNW%20615

Downing, T. Calculating Dairy Manure Nutrient Application Rates. EM 8768. Revised 2015.
https://catalog.extension.oregonstate.edu/em8768

Downing, T., D.M. Sullivan, J.M. Hart, and M. Gamroth. Manure Application Rates for Forage Production. EM 8585. Revised 2007. https://catalog.extension.oregonstate.edu/em8585

Fery, M., and E. Murphy. A Guide to Collecting Soil Samples for Farms and Gardens. EC 628. Revised 2013.
https://catalog.extension.oregonstate.edu/ec628

Horneck, D., D.M. Sullivan, J. Owen, and J.M. Hart. Soil Test Interpretation Guide. EC 1478. Revised 2011.v
https://catalog.extension.oregonstate.edu/ec1478

Resources (continued)

Manure Application Risk Management Program (ARM). Whatcom County Conservation District. http://www.whatcomcd.org/arm

Minnesota Department of Agriculture's Pre-Approved Commercial Labs http://www.mda.state.mn.us/chemicals/spills/incidentresponse/guidelist/gd23.aspx

Moore, A., and J. Ippolito. Dairy Manure Field Applications How Much is Too Much? CIS 1156. 2009. http://www.cals.uidaho.edu/edComm/detail.aspx?IDnum=1502&category1=Search&category2=NULL

Moore, A., M. de Haro-Marti, and L. Chen. Sampling Dairy Manure and Compost for Nutrient Analysis. PNW 673. 2015. https://catalog.extension.oregonstate.edu/pnw673

Sullivan, D. Estimating Plant-Available Nitrogen from Manure. EM 8954. 2015. https://catalog.extension.oregonstate.edu/em8954

Sullivan, D., and C. Cogger. Post-Harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades. EM 8832. 2003. https://catalog.extension.oregonstate.edu/em8832

Notes

Notes

Notes

Notes

Pacific Northwest Extension publications are produced cooperatively by the three Pacific Northwest land-grant universities: Washington State University, Oregon State University, and the University of Idaho. Similar crops, climate, and topography create duplication of effort, broadening the availability of faculty specialists, and substantially reducing costs for the participating states.

Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by Washington State University Extension, Oregon State University Extension Service, University of Idaho Cooperative Extension System, and the U.S. Department of Agriculture cooperating. Published May 2017. PNW506